Gary Stevens
5/24/17

Sustained Flight Power Requirements, Maximum Weight Configuration

Filename: Sustained_Flight_Power_Requirements_Max_Wt_052417

Assumptions:
- Flying weight is 9.788 lb with optional 6.0oz telemetry system and 2nd 2S3.3AH battery & cable (7.5oz) installed.
- Airspeed is 25.72MPH = 37.72ft/s = 11.50m/s = 41.39Kilometers/hr
- L/D of wing is 20.76*, so wing drag is 9.788/20.76= .4715 pound (*Clark-YH & aspect ratio of 9.68)
- Drag Force= 1/2 * mass density * Velocity^2 * Cd * Area, mass density is 1.225Kg/m^3
- Fuselage drag, worst case, 4”x4”square, thin flat plate (Cd=1.28 at 11.50m/s: 0.810Newton = 0.182 pounds force
- Empennage drag, area: 10.5sq-in, Cdrag~0.2, at 11.50m/s, Drag=0.106Newton = 0.024 pounds force
- Total drag: .471 + .182 + .024 = .677 pounds force
- Outrunner motor and ESC efficiency is 77%
- Propeller efficiency is 72%
- Solar-electric power production = 8.0V @ 9.45A = 75.6W (for zenith-Sun angle of 20°)

Sustaining Thrust = Drag= 0.677 pound

Sustaining Power = (0.677lb)(37.72ft/s)/(550ft-lb/s/HP) = 0.0457HP

Sustaining Power = (0.0457HP)(746W/HP) = 34.13W (thrust power)

Available power into ESC/ motor: 75.6W

Available shaft power out of 77% efficiency motor: 58.21W

Available thrust power out of 72% efficiency prop: 41.91W

Required Electrical Power = (34.13W mechanical) / (0.554 combined efficiency) = 61.6W (electrical power)

Surplus Electrical Power = 75.6W – 61.6W = 14.0W

Power Margin: 14.0 / 75.6 = 18.5% (in maximum weight configuration)

Climb Rate Using Surplus Power = (14.0W)(0.554 efficiency)(1HP/746W)(550ft-lb/HP-s)(1/9.788 lb)

Climb Rate Using Surplus Power = 0.584ft/s (or 35.1 ft/minute)

Options

Eliminate the 6.0oz telemetry system and the 7.5oz second LiPO battery and cable. Saves 8.6% weight. Reduces required electrical power from 61.1W to 54.7W.

Conclusion - Looking Ahead

Lighter construction techniques and materials, plus better solar cell layout could substantially improve the power margin. A 20% increase in wingspan (from 10' to 12') would allow 50% more solar cells in the wing. The higher aspect ratio would improve the finite-wingspan L/D ratio by 11%. Utilizing cut solar cells would allow a high-coverage tapered-wingtip design that would further reduce the wing's induced drag by 7-10%.